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Metallurgical pulp mill processing for the White Pine Copper Company Project, White Pine, Michigan

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METALLURGICAL PULP MILL PROCESSING FOR THE WHITE PINE COPPER COMPANY PROJECT, WHITE PINE, MICHIGAN

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PREFACE

San Francisco became aware this week that a local concern, virtually unknown in its home town, has achieved international repute.

The company, Western Machinery Company, specializes in the engineering design of ore processing plants and in the manufacture and distribution of mineral dressing and chemical processing equipment.

To make San Francisco acquainted with its achievements, the Chamber of Commerce held a special luncheon at which Jack H. How, vice president and general manager, revealed that the company will design, engineer or construct more than $80,000,000 worth of ore and coal processing plants this year. At the same time, it will manufacture and distribute millions of dollars worth of specialized machinery.

Among projects on which the company is engaged is the engineering design and supervision of construction of the $60,000,000 mine, mill and smelter facilites for the White Pine Copper Company, near Houghton, Michigan.

The Reconstruction Finance Corporation granted a $57,000,000 loan for this project to bring into production what is estimated to be the largest copper ore body on the North American Continent.

Since 1934, Mr. How said, the company has built 262 plants in the United States and foreign countries, 158 of them since the end of World War II.

The company has built plants or installed its specialized equipment in forty-seven states in this country (excepting only Maine) and in all the major mining regions of the world, including Alaska, Australia, Canada, countries of Central and

South America, France, Belgium, Finland, Austria, the Scandinavian countries, Spain, Italy, Yugoslavia, Greece, Germany, mining areas of Africa such as Morocco, Algeria, Belgian Congo, Tanganyika, Southwest Africa, Union of South Africa and also in many areas in the Mayalan States, India and the Philippines.

Among recent company projects disclosed at the chamber luncheon were a mill manufactured for Williamson Diamonds, Ltd., for operation in Tanganyika, Africa, in diamond explortion and treatment of diamondiferous gravels; a floating plant for the recovery of fine coal from river bed silts of the Ohio River, and a gravel treatment plant constructed for the Royal Canadian Air Force for use in building landing fields in the Canadian "bush."

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AND

TYPICAL BALANCE FLOW SHEET CALCULATION

The main purpose of this Balance Flow Sheet is to give us a clear picture of the Mill Water requirements, and the most economical and possible ways of conveying the Pulp through various steps of the separation process before the cleaner copper concentrates are taken to the Smelter for the refining process.

Wherever it is possible to convey the ore by gravity, launders are used. In some stages, where the fine ore has to be elevated for further distribution to the flotation cells or feeding it to the cyclones for further separation of the coarse material from the fine ores, sand pumps are made use of.

Following in order of progression on the Solids - Water - Pulp Balance Flow Sheet and on the Concentrator-General Arrangement of Launders and Sumps, the process is as follows:

Ore from the crushers and water from the line is fed to the Ball Mills, reducing its size to fine mesh, which in turn is discharged to the classifiers. Here the fine ore overflows to the launder and is taken to the classifier overflow sumps. The coarse material is returned from the classifier to the Ball Mills for regrinding.

From the Classifier Overflow Sumps, it is pumped to an elevated distributor which in turn admits the pulp to the Primary Flotation cells. Here the concentrates flow by gravity to the cleaner flotation cells, and the sands are collected in a launder and taken to the Desliming Sand Sump. From here, the pulp is fed to the Desliming Cyclone, where the slime overflows and is conveyed by the main slime tails launder to the Pumping Station to be pumped to the Tailings Pond.

The underflow which contains sands and concentrates is distributed to the Secondary Flotations, where the sands are conveyed by the main sand tails launder to the Pumping Station to be also pumped to the Tailings Pond. Here sands and slime will settle and fifty per cent (50%) of the water is regained and returned to the Mill Building for reuse.

The concentrates from the Secondary Flotation are taken by gravity to the Regrind Cyclone Sump. The tails from the Cleaner Flotation are also added to this return. These two returns together with the Regrind Mill discharge are fed to the Regrind Cyclone. Here the overflow goes back by gravity to the classifiers to follow the same cycle, and the underflow which is more coarse material goes to the Regrind Mill for more regrinding. This is a closed cycle so as the classifier return to the Ball Mill.

The concentrates of the cleaner flotation are pumped to the Thickener outside the Mill Building, where the access water is returned for further use, and the remainder is pumped to the filters where more water is extracted and returned to the Mill Building. The residual being of concentrate calcites of 18% moisture, is in form of cakes and conveyed to the Smelter Building to be processed and refined to Copper Metal Ingots.

Typical Flow Sheet

Calculations for the Classifier Overflow.

Given:

Solids = 6900 Tons per day.

Solids = 6900 ÷ 24 = 288 Tons per hour.

Solids = 2.7 Specific Gravity

Pulp to be 23% Solids.

$$\text{GPM} = \frac{\text{Tons per hour} \times 2000}{60 \times 8.33 \times \text{Specific Gravity}}$$

$$\text{GPM} = \frac{\text{T.P.H.} \times 4}{\text{SP.G.}}$$

1. - Solids:

$$\text{GPM} = \frac{288 \times 4}{2.7}$$

GPM = 425

2. - Pulp: 23% Solids

288 ÷ 23 = 1250 T.P.H.

3. - Water: 1250 - 288 = 962 T.P.H.

$$\text{GPM} = \frac{962 \times 4}{1} =$$

GPM = 3848 G.P.M.

Pulp: 425 + 3848 = 4273 G.P.M.

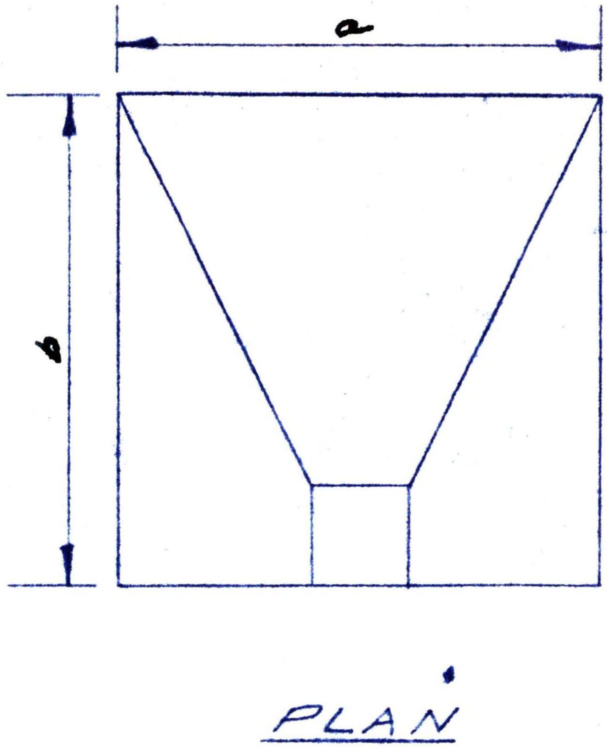
$$\text{Pulp SP.G.} = \frac{1250 \times 4}{4273}$$

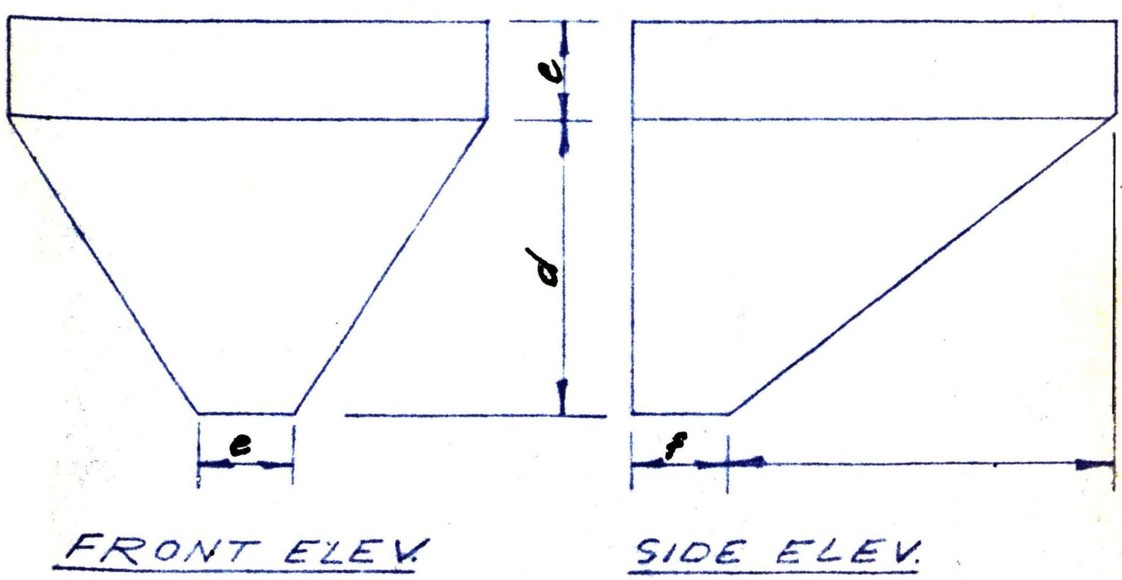
Pulp SP.G. = 1.17

Results

	Solids	Water	Pulp
SP. Gr.	2.7	1	1.17
T.P.H.	288	962	1250
G.P.M.	425	3848	4273

SUMP CALCULATIONS





CLASSIFIER OVERFLOW SUMP

a	=	12	d	=	5
b	=	12	e	=	3
c	=	8	f	=	3

Capacity

1\. - 12 x 12 x 3 = 433 C.T.

2, - $V = 1/3\ d\ [A_1 + A_2 + (A_1 \times A_2)^{1/2}]$

$A_1 = 12 \times 12 = 144$ s.f.

$A_2 = 3 \times 3 = 9$ s.f.

$V = 1/3 \times 5\ (144 + 9 + (144 \times 9)^{1/2}$

$V = 315$ c.f.

Total V = 433 + 315 = 748 c.f.

V = 748 x 7.5 = 5600 GLS.

PRIMARY DESLIMING SUMP

a = 12		d = 5
b = 12		e = 3
c = 8		f = 3

Capacity

1. - 12 x 12 x 3 = 433 C.T.

2. - $V = 1/3\ D\ [A_1 + A_2 + (A_1 \times A_2)^{1/2}]$

$A_1 = 12 \times 12 = 144$ s.f.

$A_2 = 3 \times 3 = 9$ s.f.

$V = 1/3 \times 5\ (144 + 9 + (144 \times 9)^{1/2}$

V = 315 c.f.

Total V = 433 + 315 = 748 c.f.

V = 748 x 7.5 = 5600 GLS.

SECONDARY FLOTATION, CLEANER
TAILS AND REGRIND MILL SUMP

a = 12 b = 12 c = 8

d = 5 e = 3 f = 3

Capacity

1. - 12 x 12 x 3 = 433 C.T.

2. - $V = 1/3\ d\ [A_1 + A_2 + (A_1 \times A_2)^{1/2}]$

$A_1 = 12 \times 12 = 144$ s.f.

$A_2 = 3 \times 3 = 9$ s.f.

$V = 1/3 \times 5\ (144 + 9 + (144 \times 9)^{1/2}$

$V = 315$ c.f.

Total $V = 433 + 315 = 748$ c.f.

$V = 748 \times 7.5 = 5600$ GLS.

CONCENTRATE GATHERING SUMP

a	=	6	d	=	4
b	=	6	e	=	2
c	=	6	f	=	2

Capacity

1. - 6 x 6 x 2 = 72 c.t.

2. - $V = 1/3\ d\ [(A_1 + A_2) + (A_1 + A_2)^{1/2}]$

$A_1 = 6 \times 6 = 36$ s.f.

$A_2 = 2 \times 2 = 4$ s.f.

$V = 1/3 \times 4\ [36 + 4 + (36 \times 4)^{1/2}]$

$= 69.4$ c.f.

Total $V = 69.4 + 72 = 141.4$ c.t.

$V = 141 \times 7.5 = 1060$ GLS.

MAIN CONCENTRATE GATHERING SUMP

Capacity

a = 8		d = 4	
b = 8		e = 2	
c = 5		f = 2	

1. - $V_1 = 8 \times 8 \times 1 = 64 \text{ Ft.}^3$

2. - $V_2 = 1/3 \times 4 \left[8 \times 8 + 2 \times 2 + (8 \times 8 \times 2 \times 2)^{1/2} \right]$

$= \frac{4}{3} \left[64 + 4 + (256)^{1/2} \right]$

$= \frac{4}{3} (68 + 16)$

$= \frac{84 \times 4}{3}$

$V_2 = 112 \text{ Ft.}^3$

$V_1 + V_2 = 64 + 112 = 176 \text{ Ft.}^3$

$176 \times 7.5 =$ 1320 GLS.

THICKENER UNDERFLOW SUMP

a	=	4	d	=	5
b	=	4	e	=	1
c	=	6	f	=	1

Capacity

$V_1 = 4 \times 4 \times 1 = 16 \text{ Ft.}^3$

$V_2 = 1/3 \times 5 \left[(4 \times 4 + 1 \times 1) + (4 \times 4 \times 1 \times 1)^{1/2}\right]$

$= 5/3 \ (16 + 1 + 4)$

$= \frac{5 \times 21}{3}$

$V_2 = 35 \text{ Ft.}^3$

Total $V = 16 + 35 = 51 \text{ Ft.}^3$

$Q = 51 \times 7.5 =$ 385 GLS.

FILTER OVERFLOW SUMP

a	=	4	d	=	10
b	=	4	e	=	1
c	=	11	f	=	1

Capacity

1. - $V_1 = 4 \times 4 \times 1 = 16 \text{ Ft.}^3$

2. - $V_2 = 1/3 \times 10 \left[(4 \times 4 + 1 \times 1) + (4 \times 4 \times 1)^{1/2} \right]$

$V_2 = 10/3 \ (16 + 1 + 4) = 70 \text{ Ft.}^3$

$V_1 + V_2 = 16 + 70 = 86 \text{ Ft.}^3$

$Q = 86 \times 7.5 = 650 \text{ GLS.}$

MAIN SAND TAILS SUMP

a	=	10	d	=	5
b	=	32	e	=	3
c	=	8	F	=	32

Capacity

A. - 32' x 10' x 3' = 960 $Ft.^3$

B. - $1/3 \times 5 \left[(32 \times 10 + 3 \times 3) + (32 \times 10 \times 3 \times 3)^{1/2} \right]$

$\frac{5}{3}$ (329 + 53)

$= \frac{382 \times 5}{5}$

= 640 $Ft.^3$

Total = 960 + 640 = 1600 $Ft.^3$

Q = 1600 x 7.5 = 12,000 GLS.

MAIN SLIME TAILS SUMP

a	= 10	d	= 5
b	= 32	e	= 3
c	= 8	f	= 32

Capacity

A. - $32' \times 10' \times 3' = 960 \text{ Ft.}^3$

B. - $1/3 \times 5 \; [(32 \times 10 + 3 \times 3) + (32 \times 10 \times 3 \times 3)^{1/2}]$

$$\frac{5}{3}(329 + 53)$$

$$= \frac{382 \times 5}{5}$$

$$= 640 \text{ Ft.}^3$$

Total = $960 + 640 = 1600 \text{ Ft.}^3$

Q = $1600 \times 7.5 =$ 12,000 GLS.

LAUNDER FOR CLASSIFIER OVERFLOW

1. - Branches

Given:

$4276 \div 2 = 2138$ G.P.M.

Slope = 1/3"/Ft. = .0417

Assume h = .015

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-1129

See Drawing F-196

$$Q = \frac{2138}{50 \times 7.5} - 4.75 \text{ cts.}$$

$A = ab \qquad P = a + 2b \qquad R = \frac{A}{P}$

$$AR^{2/3} = \frac{Q}{5\text{-}1/2 \times K} \qquad K = \frac{1.486}{n}$$

$$K = \frac{1.486}{.015}$$

$$= \frac{4.75}{.0417\text{-}1/2 \times 99}$$

$K = 99$

LAUNDER FOR CLASSIFIER OVERFLOW

$$AR^{2/3} = \frac{4.75}{.202 \times 99}$$

$$AR^{2/3} = .238$$

Assume a = 14" b = 6" c = 12"

$$A = 1.17 \times .5 = .585$$

$$P = 1.17 + 2 \times .5 = 2.17$$

$$R = \frac{.585}{2.17} = .27$$

$$AR^{2/3} = .585 \times .27\text{-}2/3$$

$$= .585 \times .417$$

$$AR^{2/3} = .244$$

$$.244 > .238 \qquad \text{O.K.}$$

$$V = KR^{2/3} S^{1/2}$$

$$= 99 \times .417 \times .202$$

V = 8.3 Ft./ sec. Approx.

Results:

a = 14" b = 6" c = 12"

S = 1/2"/Ft. V = 8.3 Ft./sec.

LAUNDER FOR CLASSIFIER OVERFLOW

2. - Main Launder

$Q = 4276$ G.P.M.

$S = 3/4"/\text{Ft.} = .0624$

$h = .015$

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-1129

See Drawing F-196

$Q = 4.75 \times 2 = 9.50$ cts.

$$AR^{2/3} = \frac{9.5}{.0624^{-1/2} \times 99}$$

$AR^{2/3} = .384$

Assume $a = 24"$ $b = 5\text{-}1/2"$ $c = 12"$

$A = 2 \times .458 = .916$

$P = 2 + 2 \times .458 = 2.916$

LAUNDER FOR CLASSIFIER OVERFLOW

$$R = \frac{.916}{2.916} = .315$$

$$AR^{2/3} = .916 \times .315^{2/3}$$

$$= .916 \times .462$$

$$AR^{2/3} = .42$$

$$.42 \ / \ .384 \qquad \text{O.K.}$$

$$V = KR^{2/3} S^{1/2}$$

$$= 99 \times .462 \times .25$$

$$V = 11.4 \text{ Ft./sec. Approx.}$$

Results:

a = 24" b = 5-1/2" c = 12"

S = 3/4"/Ft. V = 11.4 Ft./sec.

LAUNDER FOR SECONDARY FLOTATION CONDENTRATES AND CLEANER FLOTATION TAILS

Given:

1. - Secondary Flotation

$Q = 860$ G.P.M. @ 10% solids

Slope: 1"/Ft.

$$Q = \frac{860}{60 \times 7.5} = 1.9 \text{ cts. say } 2 \text{ cts.}$$

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-1132

See Drawing F-196

$$A = ab \qquad P = a + 2b \qquad R = \frac{ab}{a + 2b}$$

$$AR^{2/3} = \frac{Q}{S^{1/2} K}$$

$$K = \frac{1.486}{n} \qquad n = .015$$

$$K = \frac{1.486}{.015} = 99$$

LAUNDER FOR SECONDARY FLOTATION CONDENTRATES AND CLEANER FLOTATION TAILS

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K} \qquad S = .083$$

$$= \frac{2}{.083^{1/2} \times 99}$$

$$= \frac{2}{.1286 \times 99}$$

$$AR^{2/3} = .0706$$

ASSUME: a = 12" = 1' b = 3" = .25 c = 8"

$$A = 1 \times .25 = .25$$

$$P = 1 + 2 \times .25 = 1.50$$

$$R = \frac{.25}{1.50} = .167$$

$$AR^{2/3} = .25 \times .167^{2/3}$$

$$AR^{2/3} = .25 \times .31 = .075$$

.075 / .0706 O.K.

$$V = KR^{2/3} \; S^{1/2}$$

$$= 99 \times .31 \times .286$$

V = 7.5 l/sec. Approx.

Results:

a = 12" b = 3" c = 8"

V = 7.5 l/sec.

LAUNDER FOR SECONDARY FLOTATION CONCENTRATES AND CLEANER FLOTATION TAILS

2. - Secondary Flotation and Cleaner Tails

$Q = 860 + 939 = 1799$ G.P.M. @ 8% solids

Slope = 1"/Ft. = .083

$$Q = \frac{1799}{60 \times 7.5} = 4 \text{ cfs.}$$

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-1132

See Drawing F-196

$$AR^{2/3} = \frac{4}{.083^{1/2} \times 99}$$

$$AR^{2/3} = \frac{4}{.286 \times 99}$$

$$AR^{2/3} = .141$$

ASSUME:

a = 24" - 2'   b = 3" - .25'   c = 8"

A = 2 x .25 = .50

LAUNDER FOR SECONDARY FLOTATION CONCENTRATES AND CLEANER FLOTATION TAILS

$$P = 2 + 2 \times .25 = 2.50$$

$$R = \frac{.50}{2.50} = .20$$

$$AR^{2/3} = .50 \times .20^{2/3}$$

$$= .50 \times .342$$

$$AR^{2/3} = .171$$

$$.171 \;/\; .141 \qquad \text{O.K.}$$

$$V = KR^{2/3}\, S^{1/2}$$

$$= 99 \times .342 \times .286$$

$$V = 9.2\ '/\text{sec. Approx.}$$

Results:

a = 24" b = 3" c = 8"

V = 9.2'/sec.

LAUNDER FOR REGRIND MILL

Given

403 G.P.M. @ 50% solids - 1.49 s.gr.

Slope: 2"/Ft.

$$Q = \frac{403}{50 \times 7.5} = .9 \text{ cts. say } 1 \text{ cts.}$$

ASSUME n : .015

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-196

$$A = ab \qquad P = a + 2b \qquad R = \frac{ab}{a + 2b}$$

$$AR^{2/3} \quad \frac{Q}{S^{1/2} \times K} \qquad K = \frac{1.486}{n}$$

$$K = \frac{1.486}{.015} = 99$$

$$S = 2"/\text{Ft.} = .166$$

LAUNDER FOR REGRIND MILL

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K}$$

$$K = \frac{1.486}{n}$$

$$K = \frac{1.486}{.015} = 99$$

$$AR^{2/3} = \frac{1}{.166^{1/2} \times 99}$$

$$= \frac{1}{.407 \times 99}$$

$$= \frac{1}{40.4}$$

$$= .025$$

ASSUME

a = 9" = .75' b = 2" = .167' c = 6"

A = .75 x .167 = .125

P = .75 + 2 x .167 = 1.08

$$R = \frac{.125}{1.08} = .115$$

$$AR^{2/3} = .125 \times .115^{2/3}$$

$$= .125 \times .236 = .0296$$

.0296 / .025 O.K.

Results:

a = 9" b = 2" c = 6" V =

LAUNDER FOR MAIN

CONCENTRATE GATHERING SUMP

See Drawing F-190

See Drawing F-1112

PLAN

Given: Branch

Q = 400 G.P.M. @ s.gr. 1.07

Slope = 3/4"/Ft. = .0624

$$Q = \frac{400}{60 \times 7.5} = 0.89 \text{ say } 1 \text{ cfs.}$$

Assume n = .015

Assume Width = 9" = .75'

LAUNDER FOR MAIN
CONDENTRATE GATHERING SUMP

$A = ab$ $\qquad P = a + 2b$ $\qquad R = \frac{A}{P}$

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K} \qquad K = \frac{1.486}{n}$$

$$= \frac{1.486}{.015} = 99$$

$$= \frac{1}{.0624^{1/2} \times 99}$$

$$= \frac{1}{.250 \times 99}$$

$$AR^{2/3} = .044$$

By trial

Assume $a = 9"$ $\quad b = 3"$ $\quad a = .75'$ $\quad b = .25'$

$c = 6"$

$$A = .75 \times .25 = .187$$

$$P = .75 + 2 \times .25 = 1.25$$

$$AR^{2/3} = .187 \left(\frac{.187}{1.25}\right)^{2/3}$$

$$= .187 \ (.149)^{2/3}$$

$$= .187 \times .280$$

$$AR^{2/3} = .053$$

.053 / .044 O.K.

LAUNDER FOR MAIN

CONDENTRATE GATHERING SUMP

$V = KR^{2/3} \quad S^{1/2}$

$= 99 \times .280 \times .25$

$V = 6.90$ Ft./sec.

Results:

$Q = 400$ G.P.M. $\qquad S = 3/4"/\text{Ft.}$

$a = 9"$ $\quad b = 3"$ $\quad V = 6.90$ Ft./sec. $\quad c = 6"$

Given:

Main

$Q = 4 \times 400 = 1600$ G.P.M.

$S = 1\text{-}1/4" / \text{Ft.} = .1042$

Assume $n = .015$

$$Q = \frac{1600}{60 \times 7.5} = 3.55 \text{ cts.}$$

LAUNDER FOR MAIN

CONCENTRATE GATHERING SUMP

Assume $a = 18''$ $b = 3''$ $c = 6''$

$K = \frac{1.486}{.015}$

$= 99$

$AR^{2/3} = \frac{3.6}{.1042^{1/2} \times 99}$

$= \frac{3.6}{.322 \times 99}$

$AR^{2/3} = .114$

$R = \frac{A}{P} = \frac{.376}{2}$

$A = ab = 1.50 \times .25 = .376$

$P = a + 2b = 1.50 + 2 \times .25 = 2$

$AR^{2/3} = .376 \left(\frac{.376}{2}\right)^{2/3}$

$= .376 \times .188^{2/3}$

$= .376 \times .328$

$AR^{2/3} = .126$

$.126 \,/\, .114$ O.K.

$V = KR^{2/3} S^{1/2}$

$= 99 \times .328 \times .322$

$V = 10.5$ Ft./sec.

Results:

$Q = 1600$ G.P.M. $S = 1\text{-}1/4'' /$ Ft.

$a = 18''$ $b = 3''$ $V = 10.5$ Ft./sec.

$c = 10''$

LAUNDER FOR MAIN CONCENTRATE

FROM MILL TO THICKENER

Given:

FOUR SECTIONS:

330 x 4 = 1320 G.P.M.

Slope = 2.19"/Ft. = .182

ASSUME n = .015

See Drawing F-140

$$Q = \frac{1320}{60 \times 7.5} = \underline{2.94 \text{ say } 3 \text{ cts.}}$$

$$K = \frac{1.486}{.015} = 99$$

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K}$$

LAUNDER FOR MAIN CONCENTRATE

FROM MILL TO THICKENER

$$AR^{2/3} = \frac{3}{.182^{1/2} \times 99}$$

$$= \frac{3}{.425 \times 99}$$

$$AR^{2/3} = .07$$

ASSUME:

a = 18" = 1.5' b = 2" = .167 c = 10

A = ab = 1.5 x .167 = .258

P = a + 2b = 1.5 + 2 x .167 = 1.834

$$R = \frac{.258}{1.834} = .141$$

$$AR^{2/3} = .258 \times .141^{2/3}$$

$$= .258 \times .27$$

$$AR^{2/3} = .07$$

.07 = .07 O.K.

$$V = KR^{2/3}\ S^{1/2}$$

$$= 99 \times .27 \times .425$$

V = 11.3'/sec.

Results:

a = 18" b = 2" c = 10"

V = 11.3'/sec.

LAUNDERS FOR SAND TAILS AND SLIME TAILS

See Drawing F-190

See Drawing F-193

1. - **FROM SECTION 1 - 2**

ASSUME $n = .015$

$Q = 2955$ G.P.M.

$S = 1/2" /\text{Ft.} = .0417$

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K}$$

$$= \frac{6.5}{.0417^{1/2} \times 99}$$

$$AR^{2/3} = 0.325$$

$$K = \frac{1.486}{n}$$

$$K = 99$$

$$Q = \frac{2955}{60 \times 7.5} = 6.5 \text{ c.t.s.}$$

LAUNDERS FOR SAND TAILS AND SLIME TAILS

ASSUME $a = 12" = 1'$ $b = 10" = .333'$

$A = ab$ $P = a + 2b$ $R = \frac{A}{P}$

$= 1 \times .833$ $= 1 + 2 \times .833$ $= \frac{.833}{2.666}$

$A = .833$ $P = 2.666$ $R = .313$

$AR^{2/3} = .833 \times .313^{2/3}$

$= .833 \times .46$

$= 0.38$

0.38 / 0.325 O.K.

$V = KR^{2/3} \quad S^{1/2}$

$= 99 \times .46 \times .202$

$V = 9.2$ Ft./sec.

2. - FROM SECTION 2 - 3

$Q = 5910$ $S = 1/2"$ /Ft.

$Q = \frac{5910}{60 \times 7.5} = 13$ cts.

$AR^{2/3} = \frac{13}{.0417^{1/2} \times 99}$

$AR^{2/3} = .65$

LAUNDERS FOR SAND TAILS AND SLIME TAILS

ASSUME $a = 18" = 1.5'$ $b = 10" = .833$

$A = 1.5 \times .833$ $P = 1.5 + 2 \times .833$

$= 1.25$ $= 3.17$

$$R = \frac{1.25}{3.17} = .394$$

$$AR^{2/3} = 1.25 \times .394^{2/3}$$

$$= 1.25 \times .536$$

$$AR^{2/3} = .672$$

.672 / .65 O.K.

$$V = 99 \times .536 \times .202$$

$$V = 10.8 \text{ Ft./sec.}$$

3. - FROM SECTION 3 - 4

$Q = 8865$ G.P.M. $S = 1/2"/\text{Ft.}$

$$= \frac{8865}{60 \times 7.5} = 19.5 \text{ cts.}$$

$$AR^{2/3} = \frac{19.5}{.0417^{1/2} \times 99}$$

$$AR^{2/3} = .98$$

LAUNDERS FOR SAND TAILS AND SLIME TAILS

ASSUME $a = 24'' = 2'$ $b = 10'' = .833'$

$A = 2 \times .833$

$= 1.67$

$P = 2 + 2 \times .833$

$= 3.67$

$$R = \frac{1.67}{3.67} = .455$$

$$AR^{2/3} = 1.67 \times .455^{2/3}$$

$$= 1.67 \times .59$$

$$AR^{2/3} = .985$$

$.985 \;/\; .98$ O.K.

$$V = 99 \times .59 \times .202$$

$$V = 11.8 \text{ Ft./sec.}$$

4. - FROM SECTION 4 - PUMP STATION

$Q = 11{,}820$ G.P.M. $S = 1/2'' /\text{Ft.}$

$$Q = \frac{11820}{60 \times 7.5} = 26 \text{ cts.}$$

$$AR^{2/3} = \frac{26}{.0417^{1/2} \times 99}$$

$$AR^{2/3} = 1.30$$

LAUNDER FOR PRIMARY TAILS

(DESLIMING CYCLONE)

See Drawing F-190

See Drawing F-1121

See Drawing F-1122

See Drawing F-1124

See Drawing F-149

Q = 3936 G.P.M. 23% solids SP.G. = 1.17

Slope = 5/8" /Ft. = .052

$$Q = \frac{3936}{60 \times 7.5} = 8.8 \text{ c.f.s.}$$

ASSUME n = .015

$$K = \frac{1.486}{n}$$

$$= \frac{1.486}{.015} = 99$$

LAUNDERS FOR SAND TAILS AND SLIME TAILS

ASSUME a = 30" = 2.5' b = 10" = .833

A = 2.5 x .833 P = 2.5 + 2 x .833

= 2.08 = 4.1

$$R = \frac{2.08}{4.1} = .508$$

$$AR^{2/3} = 2.08 \times .508^{2/3}$$

$$= 2.08 \times .635$$

$$AR^{2/3} = 1.32$$

1.32 / 1.30 O.K.

V = 99 x .635 x .202

V = 12.8 Ft./sec.

RESULTS:

SECTION	G.P.M.	a & b - in.	V - Ft./sec.	c - in.
1 - 2	2,955	12 x 10	9.2	20
2 - 3	5,910	18 x 10	10.8	20
3 - 4	8,865	24 x 10	11.8	20
4 - PUMPS	11,820	30 x 10	12.8	20

LAUNDER FOR PRIMARY TAILS

(DESLIMING CYCLONE)

$$AR^{2/3} = \frac{Q}{S^{1/2} \times K}$$

$$= \frac{8.8}{.052^{1/2} \times 99}$$

$$= \frac{8.8}{.0227 \times 99} = \frac{8.8}{22.5} = .391$$

ASSUME $a = 24" = 2'$ $b = 6" = .5'$ $c = 12"$

$A = ab = 2 \times .5 = 1.0$

$P = a + 2b = 2 + 2 \times 1.0 = 4$

$R = \frac{A}{P} = \frac{1}{4} = .25$

$AR^{2/3} = 1 \times .25^{2/3}$

$= 1 \times .396$

$AR^{2/3} = .396 \ / \ .391$ O.K.

$V = KR^{2/3} \ S^{1/2}$

$= 99 \times .396 \times .0227$

$V = 8.9'/sec.$

Results: $S = 5/8" /Ft.$ $V = 8.9'/sec.$

$a = 24"$ $b = 6"$ $c = 12"$

PULP PROCESS PUMPING CALCULATIONS

Introduction:

In conveying solids hydraulically, it is very important to always keep a higher pipe line velocity than the usual, so that the particles in suspension will not have a tendancy to accumulate at the lower side of the pipe, thus reducing the area and many times blocking the flow entirely.

The Pump used for such processes are special pumps operating on a low R.P.M. so that the wear on the impeller can be kept at a minimum. Usually, their efficiency is lower than the ordinary water Pumps.

All places which are in contact with the pulp are either rubber lined or made out of a special steel. In this case, we have selected the rubber lined pumps which are more flexible in maintenance and can resist long wear, due to the fact that particles will bounce on the rubber lined walls instead of continuously rubbing on them.

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Preliminary Calculations of Liquid-Solid Pumps For Handling Copper Flotation Mill Pulps:

ITEM	G.P.M.	P.D. inch	P.L.V. ft/sec.	T.D.H. ft @ s.g.	P.D.P. psi
1	5,700	16-O.D.	10.3	35.49	17.30
2	5,250	14-O.D.	12.3	103.34	51.56
3	380	4-N.	9.6	27.43	12.62
4	950	6-N.	10.5	26.40	12.13
5	9,000	22-I.D.	7.6	151.00	73.20
6	11,400	24-I.D.	8.0	63.40	29.10
7	1,010	6-N.	10.2	52.00	23.76

Note:

G.P.M. : Gallons per minute.

P.D. : Pipe diameter.

P.L.V. : Pipe Line velocity.

T.D.H. : Total dynamic head.

P.D.P. : Pump discharge pressure.

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 1.

Given:

g.p.m.	=	5700	h_f	=	2.8'/100'
s.g.	=	1.13	helb.	=	27'
Pipe	=	16" O.D.	h_s	=	30'

L = 30 + 27 + 80 = 137'

H_f = 1.37 x 2.8 = 3.84'

H_s = 30 x 1.13 = 34'

H_T = 30 + 3.84 = 33.84'

$$V = \frac{5700}{7.5 \times 1.27 \times 60} = \underline{10.3'/\text{sec.}}$$

Hv = .0155 x 10.3^2 = 1.65'

T.D.H. = 33.84 + 1.65 = <u>35.49'</u> @ 1.13 s.g.

P.D.P. = (3.84 x .43 x 1.13) + (34 x .43) + (1.65 x .43)

= 1.87 + 14.72 + .71

P.D.P. = <u>17.30 p.s.i.</u>

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 2.

Given:

g.p.m	=	5250	h_f	=	5.37'/100'
s.g.	=	1.13	h_s	=	40'
Pipe	=	14" O.D.	L	=	40'

$$H_f = .40 \times 5.37 = 2.2'$$

$$H_s = 40 \times 1.13 = 45'$$

$$H = 45 + 2.2 = 47.2'$$

Pump discharges in a header of 30#

$$30 \times 2.31 \div 1.13 = 61'$$

$$H_T = 40 + 61 = 101'$$

$$V = \frac{5250}{7.5 \times 60 \times .95} = \underline{12.3'/\text{sec.}}$$

$$Hv = .0155 \times 12.3^2 = 2.34$$

$$T.D.H. = 101 + 2.34 = \underline{103.34'} \text{ @ } 1.13$$

$$P.D.P. = (2.2 \times 1.13 \times .43) + (45 \times .43) + 1 + 30$$

$$= 1.07 + 19.49 + 1 + 30$$

$$P.D.P. = \underline{51.56 \text{ p.s.i.}}$$

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 3.

Given:

g.p.m. = 380		h_f = 14.1'/100'	
s.g. = 1.07		h_s = 10'	
Pipe = 4" N.		helb. = 14'	

L = 10 + 100 + 14 = 114

H_f = 1.14 x 14.1 = 16.1'

H_s = 10 x 1.07 = 10.7'

H_T = 10 + 16 = 26'

V = 9.6'/sec.

Hv = 1.43

T.D.H. = 26 + 1.43 = 27.43' @ 1.07

P.D.P. = (16.1 x 1.07 x .43) + (10.7 x .43) + (1.43 x .43)

= 1.87 + 14.72 + .71

P.D.P. = 12.62 p.s.i.

Item 4.

Given:

g.p.m. = 950		h_f = 10.2'/100'	
s.g. = 1.07		helb. = 20'	
Pipe = 6" N.		h_s = 15 - 2 = 13	

L = 15 + 20 + 80 = 115'

H_f = 1.15 x 10.2 = 11.7

H_s = 13 x 1.07 = 13.9

H_T = 11.7 + 13 = 24.7'

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 4. (continued)

$H_v = 1.7$

$V = 10.5'/\text{sec.}$

T.D.H. = 24.7 + 1.7 = 26.4' @ 1.07 s.g.

P.D.P. = (11.7 x 1.07 x .43) + (13.9 x .43) + (1.7 x .43)

= 5.4 + 6.0 + .73

P.D.P. = 12.13 p.s.i.

Item 5.

Given:

g.p.m. = 9000 — L = 10,660'

s.g. = 1.13 — H_s = 30'

Pipe = 22 I.D. — Take C = 110

$$V = \frac{Q}{A} = \frac{9000}{7.5 \times 60 \times 2.64}$$

$V = 7.6'/\text{sec.}$

Because of the long run, we may neglect all fittings and enlargement losses; also hv.

$$f'/100' = .2083 \left(\frac{100}{C}\right)^{1.85} \times \frac{Q^{1.85}}{D^{4.86}}$$

$$f'/100' = .2083 \left(\frac{100}{110}\right)^{1.85} \times \frac{9000^{1.85}}{22^{4.86}}$$

$f'/100' = 1.14'$

H_f = 106.2 x 1.14 = 121'

H_s = 30 x 1.13 = 34

T.D.H. = 121 + 30 = 151' @ 1.13 s.g.

P.D.P. = (121 x 1.13 x .43) + (34 x .43)

P.D.P. = 58.6 + 14.6 = 73.2 p.s.i.

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 6.

Given:

g.p.m.	=	11400	L	=	2700
s.g.	=	1.07	H_s	=	30'
Pipe	=	24' I.D.	Take C	=	100
			f	=	1.24'/100'

$$V = \frac{Q}{A} = \frac{11400}{7.5 \times 60 \times 3.16}$$

$$V = \underline{8'/\text{sec.}}$$

Because of the long run, we may neglect all fittings and enlargement losses; also hv.

$$H_f = 1.24 \times 27 = 33.4$$

$$H_s = 30 \times 1.07 = 32'$$

$$\text{T.D.H.} = 33.4 + 30 = \underline{63.4 \text{ @ } 1.07}$$

$$\text{P.D.P.} = (33.4 \times 1.07 \times .43) + (32 \times .43)$$

$$\text{P.D.P.} = \underline{29.1 \text{ p.s.i.}}$$

PRELIMINARY REQUIREMENTS OF LIQUID-SOLIDS PUMPS FOR HANDLING COPPER FLOTATION MILL PULPS

Item 7.

Given:

g.p.m.	=	1010	L	=	315'
s.g.	=	1.07	Fittings	=	70'
Pipe	=	6' N.	H_s	=	5
			L_T	=	315 + 70 = 385'
			f	=	11.7'/100'

$$V = \frac{Q}{A} = \frac{1010}{7.5 \times 60 \times .19} = \underline{10.2'/sec.}$$

$$H_f = 3.85 \times 11.7 = 45'$$

$$H_T = 45 + 5 = 50$$

$$H_v = 2'$$

$$T.D.H. = 50 + 2 = \underline{52' \text{ @ } 1.07} \text{ s.g.}$$

$$P.D.P. = (45 \times 1.07 \times .43) + (15 \times 1.07 \times .43) + (2 \times .43)$$

$$P.D.P. = 20.7 + 2.2 + .86 = \underline{23.76 \text{ p.s.i.}}$$

FINAL CALCULATIONS
OF LIQUID - SOLIDS
PUMPS FOR HANDLING
COPPER FLOTATION
MILL PULPS.

CLASSIFER OVERFLOW
PUMP STATION.

CLASSIFIERS OVERFLOW PUMP STATION

See Drawing F-149

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-196

See Drawing F-1154

288 T.P.H. solids @ 2.7 s.gr. 23%

	Solids	Water	Pulp
s.gr.	2.7	1	1.17
T.P.H.	288	962	1250
G.P.M.	428	3848	4276

L - Pipe : 8 + 50 + 24 + 5' = 88' - 14" Pipe

L - Fitting: 3 - 90° = 23.5 x 3 = 70.5'

2 - TEES = 23.5 x 2 = 47.0'

1 - ENTANCE - 12 x 14 = 10'

CLASSIFIERS OVERFLOW PUMP STATION

Total L = 88 + 70.5 + 47 + 10 = 215.5' say 216'

14" PIPE: 4276 G.P.M.

h_f = 3.59'/100' V = 9.7'/sec.

H_v = 1.5'

H_f = 3.59 x 2.16 = 7.75'

H_s = 8' + 25' = 33'

T.D.H. = 7.75' + 33' + 1.5'

T.D.H. = 42.25'

P.D.P. = 42.25 x .43 x 1.17

P.D.P. = 21.3 P.S.I.

Hyd. H.P. = $\frac{4276 \times 42.25 \times 1.17}{3960}$

Hyd. H.P. = 53.5

@ 60% EFF. B.H.P = 53.5 ÷ 60 = 89

PUMP SELECTION:

ALLEN SHERMAN HOFF - D-41-5

R.P.M. - 500

B.H.P. - 87

CLASSIFERS OVERFLOW PUMP STATION

$Q = 4276 \div 2 = 2138$ G.P.M. To By Pass

$H = 4'$ $K = .82$

$$2138 = 19.64 \times .82 \times d^2 \times 4^{1/2}$$

$$d^2 = \frac{2138}{19.64 \times .82 \times 2}$$

$d2 = 56$ $d = 8.1$ USE 14" x 1.4" x 8" TEE

USE 8" VALVE

$V = 14'/sec.$

USE 8" PIPE

For a diaphragm valve such as McCanna, the P. drop across the valve is:

8" VALVE - FULL OPEN $C = 1710$

$$(P.D.)^{1/2} = \frac{Q}{C} = \frac{2138}{1710} = 1.24$$

$$P.\ Drop = 1.24^2 = 1.54 \text{ p.s.i.}$$

$$H = \frac{1.54}{1.17 \times .43} = 2.06'$$

$$4 - 3.06 = .94'$$

$$H_s = 21 + 4 = 25$$

$$H_v = 2.7'$$

CLASSIFIERS OVERFLOW PUMP STATION

T.S.H.	=.94' + 24' + 2.7' = 27.64
h_f	= 11.6'/100'
Fittings:	2 - 90° = 20.2' x 2 = 40.4
	1 - TEE 40'
PIPE	= 4 + 50 + 21 = 75'
Total L	= 75 + 40.4 + 40' = 155.5'
H_f	= 1.55 x 11.6
H_f	= 18'
NET H	= 27.64' -18' = <u>9.64'</u>
Q	= $19.64 \times Kd^2H^{1/2}$ K = .98
2138	= $19.64 \times .98\ d^2 \times 9.64^{1/2}$
d^2	= $\frac{2138}{19.64 \times .98 \times 3.12}$
d^2	= 35.5 d = 5.95"

USE 8" x 6" REDUCER

$$\frac{V^2}{2G} = 9.64$$

$$V^2 = 9.64 \times 2 \times 32.2$$

V = 25'/sec. @ NOZZLE

CLASSIFERS OVERFLOW PUMP STATION

CHECK FOR NOZZLE VELOCITY:

$$Q = AV$$

$$\frac{2138}{60 \times 7.5} = \frac{\pi 6^2 \times V}{4 \times 144}$$

$$60 \times 7.5 \times 36 \pi V = 2138 \times 4 \times 144$$

$$V = \frac{2138 \times 4 \times 144}{60 \times 7.4 \times 36\pi}$$

$$V = \underline{24.6'/\text{sec.}}$$

FLOW ADJUSTING PERMANENT BY-PASS

INSTALL A 3" PIPE WITH ADJUSTABLE NOZZLE.

MAXIMUM FLOW WITHOUT A NOZZLE IS:

$$H = \text{APPROX.} \quad 42.25' - 8' = 34.25' \qquad K = .82$$

$$Q = 19.64 \times .82 \times 3^2 \times 34.3^{1/2}$$

$$Q = \underline{850 \text{ G.P.M.}}$$

$$V^2 = H \times 2G$$

$$V^2 = 34.25 \times 64.4$$

$$V = \underline{47'/\text{sec.}}$$

PRIMARY DESLIMING PUMP STATION

See Drawing F-190

See Drawing F-1121

See Drawing F-1122

See Drawing F-1124

See Drawing F-149

Q = 3936 G.P.M. @ 1.17 s.gr.

12" PIPE - V = 11 Ft./sec.

H_v = 2' h_f = 5.4 Ft./100'

Pipe Length = 90'

Fittings = 3 x 30 = 90'

Valves:

a). CONTROL = C = 750 - 50% OPEN

Q = 3935 ÷ 6 = 660 G.P.M.

PRIMARY DESLIMING PUMP STATION

$$(PD)^{1/2} = \frac{Q}{C} = \frac{660}{750} = .88$$

$$PD = .88^2 = .76 \text{ P.S.I.}$$

$$H_L = \frac{.76}{1.17 \times .43}$$

$$H = 1.54'$$

b). 12" PLUG VALVE = 6.4' OF PIPE

ENTRANCE LOSS:

a). FROM HEADER TO 6" PIPE = .36'

b). FROM 12" PIPE TO HEADER = $\frac{61'}{3.31}$

TOTAL L = 90' + 90' + 6.4 = 186.4' + 61 = 247

$$H_f = \frac{186.4 \times 5.4}{100} = 10'$$

STATIC HEAD = 40'

TOTAL H = 2' + 1.54' + .36' + 3.3' + 10' + 40'

TOTAL H = 57.30'

57.30' x 1.17 x .43 = 28.8 P.S.I.

PRIMARY DESLIMING PUMP STATION

CYCLONE PRESSURE:

a). MINIMUM = 16 P.S.I.

b). MAXIMUM = 22 P.S.I.

PUMP DISCHARGE PRESSURE:

a). 16 + 28.5 = 44.5 P.S.I.

$$\text{T.D.H.} = \frac{44.5}{1.17 \times .43} = \underline{89 \text{ Ft. @ } 1.17 \text{ s.gr.}}$$

b). 22 + 28.5 = 50.5 P.S.I.

$$\text{T.D.H.} = \frac{50.5}{1.17 \times .43} = 101 \text{ Ft. @ } 1.17 \text{ s.gr.}$$

Pump Selection:

ALLEN SHERMAN HOFF: D - 41 -5

R.P.M.: 655 - 688

B.H.P.: 160 - 175

PRIMARY DESLIMING PUMP STATION

At full running, we shall have 3936 G.P.M. of Pulp @ 1.17 s.g. for 6 cyclones operating. - 650 G.P.M./Cyclone.

The velocity in the main line is 11'/sec.
The average Header velocity is 4'/sec. when one of the Ball Mills will be shut off, the valve at the Header will be closed, thus making use only of 3 cyclones on one side of the Header. Pulp will be 50% of 3936 = 1968 G.P.M. This Quantity is not sufficient to give us a minimum required Pipe line velocity of 7'/sec. Therefore, in order to achieve this velocity, we shall have to design a By-Pass so that we can return some of this feed to the sump and recirculate it with the new feed.

We shall take the By-Pass at each end of the Header with a flex control valve and join to a single return to the sump.
The By-Pass will be designed to return 33% of the pulp @ full valve opening and controlled with an adjustable discharge nozzle.

PRIMARY DESLIMING PUMP STATION

Pressure in the Header will vary from 16 - 22 P.S.I. - In designing the By-Pass, we shall use 16 P.S.I. as this will give us a minimum flow.

Hydl. $\frac{16}{.43 \times 1.17} = 32'$ Hs $= 28'$

H (gross) $= 32 + 28 = 60'$

Line Losses:

1. - 6" - 100' pipe carrying 33% 3936

   $h_f = 18.6'/100'$ = 1312 G.P.M.

   $H_v = 3.2'$ V = 14.4'/sec.

2. - 5 - 90^o elbows = 8.5 x 5 = 42.5

3. - 1 - Tee side outlet = 25.4'

PRIMARY DESLIMING PUMP STATION

4. - entrance loss from 12" to 6" = 1.2'

Total equivelant length of pipe:

L_p = 100' + 42.5' + 25.4' = 167.9' say 168'

H_f = 1.68 x 18.6 = 31.3'

H_v = 3.2'

H_e = 1.2

Total Loss 35.7' say 36'

Net head @ nozzle = 60' - 36' = 24'

K = .82

$$Q = 19.6 \times K \times d^2 \sqrt{h}$$

$$1312 = 19.6 \times .82 \times d^2 \times 24^{1/2}$$

$$d^2 = \frac{1312}{19.6 \times .82 \times 4.9}$$

$d^2 = 16.7"^2$ d = 4.1"

USE a <u>6" x 4" reducer.</u>

66% 3936 = 2624 G.P.M. flowing thru the 12" Pipe with a velocity of 7.4'/sec. O.K.

CONCENTRATE GATHERING PUMP STATION

See Drawing F-190

See Drawing F-1112

See Drawing F-149

GIVEN:

212 T.P.D. solids @ 10% - 3.2 s.gr.

	Solids	Water	Pulp
S.Gr.	3.2	1	1.08
T.P.H.	8.8	79.2	88
G.P.M.	11	316.8	327.8

88.0
8.8
———
79.2

$$G.P.M. = \frac{T.P.H. \times 4}{S.Gr.} = \frac{8.8 \times 4}{3.2}$$

CONCENTRATE GATHERING PUMP STATION

Q = 330 G.P.M. 4" PIPE

L_P = 8 + 95 + 10 + 20 + 4 = 137'

L_F = 10.2 x 4 = 40.8 say 50'

Total L = 137 + 50 = 187'

V = 8.24'/sec.

h_f = 10.5'/100'

Disregard Sump Head - Not Constant.

H_s = 8' - 4' = 4' Normal running

H_v = 1.05'

H_F = 1.87 x 10.6 = 19.8'

Total H = 19.8' + 4' + 1.05' = 24.85'

PUMP DISCHARGE PRESS:

24.85 x .43 x 1.08

P.D.P. = 11.6 P.S.I.

Hyd. H.P. = $\frac{330 \times 11.6}{1714}$

Hyd. H.P. = 2.23

@ 50% EFF - B.H.P. = 2.23 ÷ .5 = 4.5

B - 41 - 5 -A.S.H. - R. P.M. = 650 B.H.P. = 5.05

MAIN CONCENTRATE GATHERING PUMP STATION

ONE SECTION

Q = 330 @ 1.08 s.gr. 4" PIPE

L_p = 8' + 80' + 120' + 14' + 190' + 40' + 13' + 50' + 2'

L_p = 517'

L_F = (8 x 10.2) + (1 x 2.1) = 83.7'

Total L = 517' + 83.7 = 600'

h_f = 10.6'/100' V = 8.24'/sec.

H_f = 10.6 x 6 = 63.6'

H_s = (2264'-6" + 2') - 2274 - 2)

H_s = 5'-6"

H_v = 1.05'

T.D.H. = 63.6' + 5.5' + 1.05'

T.D.H. = 70.15'

P.D.P. = 70.15 x .43 x 1.08

P.D.P. = 32.6 P.S.I.

Hyd.H.P. = $\frac{330 \times 32.6}{1714}$ = 6.3

B.H.P. = 6.3 ÷ .6 = 10.5

MAIN CONCENTRATE GATHERING PUMP STATION

TWO SECTIONS

Q	=	660 G.P.M. @ 1.08 s.gr.				5" PIPE
L_p	=	517'	L_F	=	83.7'	
Total L	=	600'	h_f	=	13.2'/100'	
			V	=	10.8'/sec.	
H_f	=	6 x 13.2		=	79.2'	
H_s	=	5.5'				
H_v	=	1.05'				
T.D.H.	=	79.2 + 5.5 + 1.05'		=	<u>87.75'</u>	

P.D.P. = 87.75 x .43 x 1.07

P.D.P. = 41 P.S.I.

Hyd.H.P. = $\frac{660 \times 41}{1714}$ = <u>15.7</u>

@ 60% EFF = 15.7 ÷ .6 = <u>26.2</u>

MAIN CONCENTRATE GATHERING PUMP STATION

THREE SECTIONS

Q = 330 x 3 = 990 G.P.M. @ 1.08 s.gr.

L_P = 517' L_F = 83.7 Total L = 600'

h_f = 10.6'/100' V = 10.7'/sec. - 6" PIPE

H_f = 6 x 10.6 = 63.6

H_s = 5.5'

H_v = 1.05'

T.D.H. = 63.6 + 5.5 + 1.05

T.D.H. = 70.15'

P.D.P. = 70.15' x .43 x 1.08

P.D.P. = 32.6 P.S.I.

Hyd.H.P. = $\frac{990 \times 32.6}{1714}$ = 18.8

@ 60% EFF. B.H.P. = 18.8 ÷ .6 = 31.4

ASH. - BC - 41 - 5

R.P.M. = 1035

B.H.P. = 32.4

MAIN CONCENTRATE GATHERING PUMP STATION

FOUR SECTIONS

Q = 330 x 4 = 1320 G.P.M. @ 1.08 s.gr.

L_P = 517' L_F = 83.7'   Total L = 600'

h_f = 19.3'/100' - 6" PIPE   V = 14.8'/sec.

H_f = 19.3 x 6 = 115.8'

H_s = 5.5'

H_v = 1.05'

T.D.H. = 115.8' + 5.5' + 1.05

T.D.H. = 122.4'

P.D.P. = 122.4 x .43 x 1.08

P.D.P. = 57 P.S.I.

Hyd.H.P. = $\frac{1320 \times 57}{1714}$ = 44

@ 60% B.H.P. = 44 ÷ .60 = 73.5

ALTERNATE FOR MAIN CONCENTRATES GATHERING PUMP STATION

See Drawing F-190

See Drawing F-149

THREE SECTIONS

	Q	= 330 x 3 = 990 G.P.M. @ 1.08 s.gr.		
6" PIPE -	L_P	= 15 + 72' + 25'	= 112'	
	L_F	= 15.3 x 2	= 30.6'	say 31'
	Total L_P	= 112' + 37'	= 143'	
	V	= 10.7'/sec.	h_f = 10.6'/100'	
	H_v	= 1.8'	H_s = 40'	

ALTERNATE FOR MAIN CONCENTRATES GATHERING PUMP STATION

H_f = 10.6 x 1.43

H_f = 15.2'

T.D.H. = 15.7 + 40 + 1.80

= 57.50 @ 1.08 s.gr.

P.D.P. = 57.50 x .43 x 1.08

= 26.7 P.S.I.

Hyd.H.P. = $\frac{990 \times 26.7}{1714}$ = 15.2 H.P.

FOR 55% EFF. = 15.2 ÷ .55 = 27.6 B.H.P.

FOR ASH - BC - 41 - 5 PUMP

R.P.M. = 938

B.H.P. = 25 x 1.08 = 27

REGRIND CYCLONE PUMP STATION

See Drawing F-149

See Drawing F-190

See Drawing F-195

See Drawing F-197

See Drawing F-196

PIPE: Select a size that will give a satisfactory velocity within the range of 2750 - 5500 G.P.M.

14" Gives: 5.2'/sec. - 12.4'/sec.

HEADER: We connect to the header at the center; thus dividing the flow equally; distributed to the cylones.

REGRIND CYCLONE PUMP STATION

FOR MAXIMUM CAPACITY:

5500 G.P.M. @ 10% solids

2750 G.P.M. 2750 G.P.M.

12" HEADER @ 2750: V = 7.57'/sec.

FOR MINIMUM CAPACITY:

4000 G.P.M. @ 10% solids

2000 G.P.M. 2000 G.P.M.

17" HEADER @ 1900: V = 5.68'/sec.

PUMP:

DESIGN WILL INCLUDE TWO ASSUMPTIONS.

ONE PUMP: 4000 G.P.M. @ 1.09 s.g. 10% Solids

14" PIPE: h_f = 3.32'/100'

H_v = 1.35

V = 9.31'/sec.

REGRIND CYCLONE PUMP STATION

PIPE LENGTH = 10 + 27 + 20' + 16' = 73'

FITTING EQVLT.:

3. - 14" - 40' ELB. = 23.5 x 3 = 70.5

1. - 14" TEE - SIDE OUTLET = 71'

1. - 12" FLEX - CONTROL VALVE FULL OPEN

H = 1.13'

1. - 6" FLEX VALVE 3/4 OPEN: H = 0.37

1. - 6" x 14" REDUCTION: H = .16'

1. - 6" TO CYCLONE: H = .37'

TOTAL L = 73 + 70.5' + 71' = 214.5 USE 215.0'

H_f = 2.15 x 3.32 = 7.1'

H_s = 29'

CYCLONE MAXIMUM PRESS = 30 P.S.I. = $\frac{30}{.43 \times 1.09}$ = 64'

H_v = 1.35'

T.D.H. = 7.1 + 30' + 65' + 1.35' + 1.13' + 0.16' + 0.37' + 0.37'

T.D.H. = 104.5' P.D.P. = 104.5 x .43 x 1.09 = 50 P.S.I.

REGRIND CYCLONE PUMP STATION

TWO PUMPS:

5500 G.P.M. 2750 G.P.M. PER PUMP

14" PIPE: h_f = 1.6'/100'

H_v = 0.6'

V = 6.2'/sec.

PIPE LENGTH AND FITTINGS = 215'

1. - 12" FLEX - CONTROL VALVE: H = 0.54'
1. - 6" FLEX VALVE 3/4 OPEN: H = 0.73
1. - 6" x 14" REDUCTION: H = 0.31'
1. - 6" TO CYCLONE: H = 0.71'

H_f = 2.15 x 1.6 = 3.45'

H_s = 29'

CYCLONE PRESS: 30 P.S.I. = 65'

H_v = 0.6'

T.D.H. = 3.45' + 30' + 64' + 0.54' + 0.73' + 0.31 + 0.71' + 0.6'

T.D.H. = 100.34' P.D.P. = 100.34 x .43 x 1.07 = 46 P.S.I.

REGRIND CYCLONE PUMP STATION

RESULTS:

ONE PUMP - ASH: D - 41 - 5 - 4000 G.P.M.

CYCLONE PRESS	R.P.M.	B.H.P.
25 P.S.I.	667	153
30 P.S.I.	700	168

TWO PUMPS - ASH: D- 41 - 5 - 5500 G.P.M.

CYCLONE PRESS	R.P.M.	B.H.P.
25 P.S.I.	640	110
30 P.S.I.	670	118

MAIN SLIME TAILINGS PUMP STATION

See Drawing F-193

PLAN

Q = 10,224 G.P.M. @ 1.09 s.gr.

Bottom of sump at the Pumping House is Approximately 30' below floor elevation at Mill Building for a 22" wood stave pipe;

USE c = 110 and Factor = .84

MAIN SLIME TAILINGS PUMP STATION

FOR 10,224 G.P.M.: h_f = 1.62 x .84 = 1.36 Ft./100'

V = 7.34 x 1.19 = 8.7 Ft./sec.

1/2 MILE = 2640'

H_f = 26.4 x 1.36 = 36'

H_v = (.79 + .05) 1.42 = 1.2'

$H_f + H_v$ = 36 + 1.2 = 37.2 Ft.

Therefore, we shall have to elevate the pipe @ the Pump House 37.2' above discharge to be able to maintain the required Q and V.

Pump House Floor Elevation = 2264' - 30' = 2234'

Suction Elevation including A 6" Concrete Pad is: 2236'-4".

T.D.H. = 37.2' @ 1.09 s.gr.

PUMP DISCHARGE PRESSURE = 37.2' x .43 x 1.09

P.D.P. = 17.4 P.S.I.

A.S.H. PUMP - D - 41 - 5

10,224 ÷ 3 = 3408 G.P.M./PUMP

MAIN SLIME TAILINGS PUMP STATION

3408 G.P.M. @ 37.2':

R.P.M. = 450

B.H.P. = 54.0 x 1.09 = 59

Install 4 Pumps -

One as a stand-by.

THICKENER UNDERFLOW PUMP STATION

See Drawing 140

GIVEN:

A). 850 T.P.D. - Solids @ 50% - 3.2 s.gr.

B). 370 T.P.S. - Solids @ 50% - 3.2 s.gr.

CONDITION A:

850 T.P.D. = 35.4 T.P.H.

	Solids	Water	Pulp
S.Gr.	3.2	1	1.53
T.P.H.	35.4	35.4	70.8
G.P.M.	43	141.6	184.6

THICKENER UNDERFLOW PUMP STATION

L_P = 10 + 110 + 60 + 30 + 6 + 5 = 221'

L_F = 7 - 90° Elb. - 4" Pipe = 10.2 x 7 = 71.4'

1 - 45° Elb. = 4.7'

1 - Tee - Side Outlet = 20.2'

Total L = 221 + 71.4 + 4.7 + 20.2 = 317.2' say 320'

185 G.P.M. - 4" - h_f = 3.65'/100' V = 4.6'/sec.

H_f = 3.2 x 3.65 = 11.7'

H_s = 65.25'

$H_s + H_f$ = 65.25 + 11.7' = 76.95' say 77'

T.D.H. - Pulp = 77' @ 1.53 s.gr.

PUMP DISCHARGE PRESSURE = 77 x .43 x 1.53

P.D.P. = 51 P.S.I.

Hyd. H.P. = $\frac{\text{G.P.M. x P.S.I.}}{1714}$

= $\frac{185 \times 51}{1714}$

Hyd. H.P. = 5.5

For a 60% Eff. = 5.5 ÷ 60 = 9.15 say 10 H.P.

B.H.P. = 10

THICKENER UNDERFLOW PUMP STATION

Condition B   370 T.P.D. = 15.4 T.P.H.

	Solids	Water	Pulp
S.Gr.	3.2	1	1.53
T.P.H.	15.4	15.4	30.8
G.P.M.	19.3	61.6	80.9

L_P = 221' L_F = 73'

Total L = 221 + 73 = 294' say 300'

3" Pipe @ 85 G.P.M. - h_f = 3.31'/100'   V = 3.7'/sec.

H_f = 3 x 3.31 = 9.93'

H = $H_s + H_f$ = 65.25 + 9.93

H = 75.2' say 76'

PUMP DISCHARGE PRESSURE = 76 x .43 x 1.53

P.D.P. = 50 P.S.I.

For 60% Eff.

$$\text{B.H.P.} = \frac{85 \times 50}{1714 \times .60}$$

B.H.P. = 4.1 say 4.5

THICKENER UNDERFLOW PUMP STATION

Condition C-1

600 T.P.D. = 25 T.P.H. 50% solids

	Solids	Water	Pulp
S.Gr.	3.2	1	1.53
T.P.H.	25	25	50
G.P.M.	31.2	100	131.2

L = 221' L_F = 73'

Total L = 221 + 73 = 294' say 300'

3" Pipe @ 131.2 G.P.M. h_f = 7.3'/100'

V = 5.64'/sec.

H_f = 3 x 7.3 = 21.9

H = $H_s + H_f$ = 65.25 + 21.9

H = 87.2'

PUMP DISCHARGE PRESSURE = 87.2 x .43 x 1.53

P.D.P. = 57.5 P.S.I.

50% B.H.P. = $\frac{131.2 \times 57.5}{1714 \times .50}$

B.H.P. = 8.8 say 9

THICKENER UNDERFLOW PUMP STATION

C - 2

600 T.P.D. - 40% solids - 3.2 s.gr.

	Solids	Water	Pulp
S.Gr.	3.2	1	1.38
T.P.H.	25	37.5	62.5
B.P.M.	31.2	150	181.2

L = 221' L_F = 73'

Total L = 221 + 73 = 294' say 300'

3" PIPE @ 181 G.P.M. h_f = 14'/100'

V = 7.8'/sec.

H_f = 3 x 14 = 42

Total H = 65.25 + 42 = 107.3'

P.D.P = Say 110' = 47.6 x 1.38 = 66 P.S.I.

$$B.H.P. = \frac{66 \times 181.2}{1714 \times .50}$$

B.H.P. = 14

THICKENER OVERFLOW PUMP STATION

H_s = 24'   Q = 1,200 G.P.M.

Pump Floor Elevation = 2243'-3"

Tank Elevation = 2365'-9"

H_s = 122'-6"

See Drawing F-1107

See Drawing F-140

See Drawing F-101

See Drawing G-62-SK

THICKENER OVERFLOW PUMP STATION

GIVEN: G.P.M. = 1200

L = 700'

Fittings = 100'

Tank Grade Elevation = 2265'-0"

Pump Grade Elevation = 2243'-3"

21.75'

H_{sp} @ Pump = 24'

H_{sT} @ Tank = 122.5' + 21.75' = 144.25'

$H_{sT} - H_{sT}$ = 144.25 - 24 = 120.25' say 121'

For a Standard 8" PIPE @ 1200 G.P.M.

hf = 4.23'/100' V = 7.7'/sec.

H_f = 7 x 4.23 = 29.6'

$H_f + H_s$ = 29.6 + 120.3 = 149.9'

Say H = 150' = 65 P.S.I.

PUMP DISCHARGE PRESSURE = 70 P.S.I.

$$\text{Hyd. H.P.} = \frac{\text{G.P.M.} \times \text{P.S.I.}}{1714} = \frac{1200 \times 70}{1714}$$

Hyd. H.P. = 49

For 85% EFF. B.H.P. = 49 ÷ .85 = 57.5

BALL MILL CLEAN-UP PUMPS

Possible Maximum G.P.M. = 200 @ 1.17 sp.g.

Static Head = 20'

EQV. Pipe Length 75'

Pipe Diameter = 3"

h_f = 16.1'/100' H_v = 1.17' V = 8.7'/sec.

H_f = 16.1 x 0.75' = 12.1'

T.D.H. = 20 + 1.17 + 12.1 = 33.3 Ft.

P.D.P. = 33.3 x 1.17 x .43 = 16.8 P.S.I.

Hyd.H.P. = $\frac{16.8 \times 200}{1.714}$ = 1.95

PUMP SELECTION.

SELECT A "WEMCO" 3" PUMP

R.P.M. = 970

B.H.P. = 6.4

LIME BALL MILL PUMP

Intermitant Pumping, requiring 270 G.P.M. while Ball Mill is operating.

G.P.M. = 270 @ 1.06 sp.g.

Static Head = 24'

Eqv. Pipe Length = 200'

Pipe Diameter 4"

h_f = 7.4'/100' H_v = 0.70' V = 6.72'/sec.

H_f = 7.4 x 2.7 = 20'

T.D.H. = 20' + 0.70' + 24' = 44.7'

$$\text{Hyd. H.P.} = \frac{270 \times 44.7 \times 1.06}{3960} = 3.2$$

PUMP SELECTION

SELECT A "WEMCO" 3" PUMP

R.P.M. = 1130

B.H.P. = 9.6

MILL BUILDING FLOOR SUMP PUMPS

CIRCULATING LOAD 150 G.P.M. @ 1.06 sp.g.

Static Head = 30'

Eqv. Pipe Length = 1300'

Pipe Diameter 4"

h_f = 2.53'/100' H_v = 0.22'   V = 3.8'/sec.

H_f = 2.53 x 13 = 33.3'

T.D.H. = 33.3' + 30' + 0.22' = 63.5'

$$\text{Hyd.H.P.} = \frac{150 \times 63.5 \times 1.06}{3960}$$

$$= 2.55$$

PUMP SELECTION

SELECT A "WEMCO" 3" PUMP

R.P.M. = 1300

B.H.P. = 11.6

LIME CIRCULATING PUMP

There will be 6 vertical sump pumps:

3 on - D - discharging to the sand tails.

3 on - F - discharging to the classifiers.

Maximum static head will be on the pumps discharging to the classifiers

Sump depth = 2264' - 2258 = 6'

Static discharge = 2285 - 2264 = 21 + 6 = 27'

Eqv. pipe length = 100' - 3" Pipe

Each pump should handle a minimum of 100 G.P.M. @ the head specified @ 1.17 s.g.

h_f = 4.98'/100' H_v = .39' V = 4.99'/sec.

H_f = 4.98

T.D.H. = 27' + 4.98 + 0.39 = 32.37'

Hyd. H.P. $= \dfrac{32.4 \times 100 \times 1.17}{3960} = 1$

PUMP SELECTION

SPRAYS AND SAND PUMPS SEALING WATER PUMP STATION

See Drawing F-1107

Calculations.

1. - Spray Water:

This line will be elevated approximately 21' from the floor. Quantity and pressure requirements for Launder Spraying are 3500 G.P.M. @ 20 - 30 P.S.I. Assure the furthest spray nozzle to be approximately 550' from the top location. The main water line in the Mill is 24" - 15,000 G.P.M. - 3' above Floor @ approximately 60 P.S.I.

SPRAYS AND SAND PUMPS SEALING WATER PUMP STATION

The 3500 G.P.M. may be divided into 4 sections each taking equal amount of water - 875 G.P.M. @ 21' Elevation 21 - 3 = 18' static.

138' - 18' = 120' = 52 P.S.I.

10" Pipe - 3500 G.P.M. - h_f = 10'/100'

L = 200 + 100 = 300'

H_f = 3 x 10 = 30' = 13 P.S.I.

A. - Pressure @ A = 52 - 13 = 39 P.S.I.

B. - From A - B = 3500 - 875 = 2625 G.P.M.

8" Pipe - 2625 G.P.M. - h_f = 18'/100

H_f = 18' = 8 P.S.I.

39 - 8 = 31 P.S.I.

C. - From B - C = 2625 - 875 = 1750 G.P.M.

8" Pipe - 1750 G.P.M. - h_f = 8'/100'

H_f = 8' = 3.5 P.S.I.

SPRAYS AND SAND PUMPS SEALING WATER PUMP STATION

D. - From C - C - 875 G.P.M. 6" Pipe h_f = 8.8'/100'

H_f = 8.8' = 3.8 P.S.I.

27.5 - 3.8 = 23.7 P.S.I.

These pressures will be 1 - 2 P.S.I. less due to valves and fittings which will not reduce the required pressure for spraying - 20 - 30 P.S.I. - .

Sealing water demand is 500 G.P.M. and may be divided a). Low Pressure, b). High Pressure. - Though the high pressure demand for sealing will not exceed 200 G.P.M., we should select a booster Pump that could deliver 400 G.P.M. for any additional high pressure process. The low Pressure sealing demand may be assumed about 250 G.P.M. and the Pressure will not exceed the main line water Pressure - 60 P.S.I.

SPRAYS AND SAND PUMPS SEALING WATER PUMP STATION

Booster Pump.

400 G.P.M. - ASSUME a 4" Pipe 400' and the average line Pressure to be approximately 100 P.S.I.

The booster will receive at 60 P.S.I. - 3' above floor.

400 G.P.M. = 4" - h_f = 15.5'/100'

$$4 \times 15.5 = 62' = 26.8 \text{ P.S.I.}$$

$$\frac{x + (x - 26.8)}{2} = 100$$

$$2x = 226.8$$

$$x = \underline{113.4} = \text{PUMP DISCHARGE PRESSURE}$$

Say 115 P.S.I.

$$115 - 60 = 55 \text{ P.S.I.}$$

$$\text{B.H.P.} = \frac{400 \times 55}{1714 \times 85}$$

$$\underline{\text{B.H.P.} = 15}$$

THICKENER UNDERFLOW PIPING CALCULATIONS

See Drawing F-140

For 4 sections of the Ball Mill = 185 G.P.M.

@ 50% solids s.gr. = 1.53

L_P = 60'

L_F = 1 - TEE = 6.8' 1 - 90° Elb. = 6.8'

3 - 45° Elb. = 4.7 x 3 = 14.1'

1 - TEE - Side Outlet = 20.3'

3 - GATE VALVES = 2.1 x 3 = 6.3'

L_F = 6.8' + 6.8' + 14.1 + 20.3' + 6.3' = 54.3'

Total L = 60 + 54.3 = 114.3' say 115'

185 ÷ 2 = 92.5 G.P.M. say 93

4" PIPE - h_f = 1.05'/100'

H_F = 1.05 x 1.15 = 1.21'

THICKENER UNDERFLOW PIPING CALCULATIONS

0.2" Per Ft. Drop = 1" Per 5' Drop

1"/5' For 4" PIPE CAN OVERCOME FRICTION FOR 190 G.P.M. - IN OUR CASE WE HAVE 93 G.P.M.; THEREFORE, WE ARE SAFE AND THE H. LOSS OF 1.21 WILL NOT HAVE TO BE DEDUCTED FROM THE S. HEAD OF 15'

$$Q = 19.64 \times K \times d^2 \times H^{1/2} \qquad K = .61$$

$$93 = 19.64 \times .61 \times d^2 \times 15^{1/2}$$

$$d^2 = \frac{93}{19.64 \times .61 \times 3.88}$$

$$d^2 = \frac{93}{46.4}$$

$$d^2 = 2 \qquad d = 1.42" \qquad \underline{\text{USE } 1.5"}$$

$$\text{PIPE V.} = \underline{2.35'/\text{sec.}}$$

$$\text{NOZZLE V.} = \frac{93}{7.5 \times 60} \div \frac{1.77}{144}$$

$$= .207 \div .0123$$

$$\text{NOZZLE V.} = \underline{16.8'/\text{sec.}}$$

SAND TAILS PIPE LINE AND PUMPING STATION

PUMP HOUSE LOCATIONS

N - 35,161.24 E - 32,105.03

Floor Elevation: 2230'-0"

Suction Elevation: 2232'-4"

PIPE DISCHARGE LOCATION

N - 35,153.12 E - 35,100 E - 38100

E - 36300

Discharge of the line will start at the nearest creek (E - 35000) and will be prolonged according to future requirements up to the last creek (E - 38,100).

A). FOUR SECTIONS OF THE CONCENTRATOR:

Q = 11,920 G.P.M. @ 1.13 SP.G.

Four pumps will be installed: three operating simultaneously, one as a stand by. Each pump will be calculated to dispose 11,820 ÷ 3940 G.P.M./Pump.

Installing a 24" Wood Stave Pipe

USE C = 110 and F = .84

For 11,820 G.P.M.

V = 8.4'/sec.

SAND TAILS PIPE LINE AND PUMPING STATION

h_f = 1.37 x .84 = 1.16'/100'

H_v = 1.12'

H_f = 1.16' x TOTAL PIPE LENGTH.

38,100 - 32,039 = 6,061 Ft.

H_f = 1.16 x 60.61 = 71'

h_s = Suction elevation = 2232'-4"

Discharge Elevation @ E-39250 = 2285'

H_s = 2265' - 2232' = 33'

H. = $H_f + H_s + H_v$

= 71' + 33' + 1.12'

T.D.H = 105.12'

P.D.P. = 105 x .43 x 1.13

= 51 P.S.I.

Pump Selection

D-41-5 -

R.P.M. = 700

B.H.P. = 172

TREE SECTIONS OF THE CONCENTRATOR

= 8865 G.P.M. @ 1.13 SP.G. - 24" W.S.PIPE

SAND TAILS PIPE LINE AND PUMPING STATION

During this period two pumps ope rating simultaneously will pump away the sand tails; the other two will serve as a stand by and for future expansion.

H_f = 60.61 x .675' = 40.5'

H_s = 33' H_v = .63

T.D.H. = $H_f + H_s + H_v$ =

40.5' + 33' + .63

T.D.H. = 74.13'   P.D.P. = 74.13 x .43 x 1.13

= 36 P.S.I.

EACH PUMP SHALL DISPOSE:

8865 ÷ 2 = 4432 G.P.M./PUMP

PUMP SELECTION: A.S.H. D-41-5

R.P.M. = 616

B.H.P. = 142

V I T A

The author was born September 18, 1921, at Istanbul, Turkey. After his primary education, he attended Robert College, Istanbul, Turkey, where he graduated with a Bachelor of Science in Mechanical Engineering in September, 1946.

Upon his graduation, he accepted a position with the British European Airways in Istanbul, Turkey, where he worked for a year, before being employed by the Bureau of Highways of The Turkish Government, Ankora Turkey.

In March, 1950, he was granted a leave to go to the United States of American for higher studies.

From 1950 to 1951, he attended the University of Missouri, School of Mines and Metallurgy at Rolla, Missouri, as a graduate assistant for the Mechanical Engineering Department, from which he received the Degree of Master of Science in Mechanical Engineering, July, 1951.

Following his graduation, he accepted employment with Sargent and Lundy Engineers of Chicago, in connection with the Design and Layout of Power Plants.

Since August, 1952, he has been employed by Western-Knapp Engineering Company, Division of Western Machinery Company, with the capacity of Chief Designer-Engineer in connection with the design and layout of steam, water, air, pulp and pumping installation for the White Pine Copper Company Project, of White Pine, Michigan, in which capacity, he still serves.